

a. Project title

**Predicting marsh bird population response to sea level rise: Providing information for management decisions and a framework for other marsh species**

b. Name of reserve at which the project will be conducted and the priority management need

**North Carolina National Estuarine Research Reserve System**

(NC NERRS Specific Reserves: Rachel Carson Reserve, Masonboro Island, Zeke's Island, Bird Island)

c. Proposed project period (start date must be August 1 or September 1, 2020 and end dates)

**Start Date September 1<sup>st</sup>, 2020, End August 31<sup>st</sup> 2022**

d. Applicant (name, organization, and contact information)

**Marae Lindquist, University of North Carolina Wilmington, mcl6280@uncw.edu**

e. Student's university and degree being sought

**University of North Carolina Wilmington, PhD Marine Biology**

f. Anticipated graduation year

**Spring 2023**

g. Faculty advisor or University sponsor (name, organization, and contact information)

**Raymond Danner, University of North Carolina Wilmington, dannerr@uncw.edu**

h. Recipient name (must match registered name in Dun and Bradstreet Universal Numbering System (DUNS)). This is typically the University at which the student is enrolled.

Recipient DUNS number (must match applicant information in SAM.Gov)

**University of North Carolina Wilmington 040036584**

i. Financial representative (names, organization, and contact information)

**Justine Reel, Interim Director of Sponsored Programs & Research Compliance reelj@uncw.edu**

j. Requested funding by year

**\$61,090 per year**

k. If the project is intended to be administered under an existing NOAA Cooperative Institute, state which Institute will administer the award

**Not a NOAA Cooperative Institute**

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## Section 2: Statement of Interest

The overarching focus of my research stems out of my passion for avian biology and habitat conservation. While performing research over the past few years I have gained an appreciation for coastal estuarine ecosystems; especially for the species who have specialized to thrive in harsh and complex ecosystems. I look to expand my research spatially and temporally with the Margaret A. Davidson Fellowship and procure invaluable experience with the professional development and cohort opportunities that the fellowship provides.

I am a Marine Biology PhD student at the University of North Carolina Wilmington (UNCW). I first began at UNCW as a master's student in the Fall of 2018, and after one field season quickly realized that I wanted to pursue a PhD. I am currently in the second year of the PhD program, and by Fall of 2020 I will have completed 49 out of the 78 credit hours required and will only have to take 5 credit hours per semester until my planned graduation date in Spring 2023. I have gained a plethora of skills while in graduate school. I have learned how to capture and safely process birds ranging from small passerines to large shore birds using a multitude of capture methods and gained many useful field skills such as boating, trailering, and radio telemetry. I have also learned many computer and programming skills such as ArcGIS and R Statistical software, which are important for my current and future research.

My research focuses on avian population biology and the impacts of climate change in estuarine systems as a framework for conservation. The objectives of the first chapter of my dissertation are to describe the winter movements of Saltmarsh and Seaside Sparrows and then estimate densities of both species at our study sites. The objective of my second chapter is to predict how sea level rise will affect the extent of tidal marsh habitats used by Saltmarsh and Seaside Sparrows at our study sites in southeastern NC and understand how this may limit their population sizes. The research I am proposing would form the third and final chapter of my dissertation research. This research would leverage research methods used in my first two chapters but expand it spatially and temporally to assist the NC NERRS in gathering essential knowledge about avian populations and the impacts of sea level rise.

After I complete my degree, I plan to pursue a career in science higher education. I see myself teaching courses focused on coastal ecology, population biology, and conservation and focusing on the conservation of avian habitat. I have had wonderful professors show me the importance of conveying knowledge and having passion for what you are teaching, and I strive to do this for others. I currently am a teaching assistant for Ecology Lab at UNCW and I teach two lab sections during each fall semester. Graduate school has really taught me how little I know; every day I learn something new and realize the depths of knowledge we can gain and transfer to others. I also think mentorship is essential to the success of students. I have been a mentee and learned so much from my mentors, and I am also a mentor to undergraduate students, and I have two undergraduate research assistants that I am mentoring in the spring semester. I hope to inspire my mentees like I have been inspired and instill in them a passion for coastal ecology and avian conservation.

Professional development and outreach are vital to the success of academics and professionals in science. I strive to attend and present at multiple conferences and meetings each year, and I have been thrilled with the experience I have gained thus far by attending and presenting at meetings and conferences. This fellowship provides amazing opportunities to expand on my professional network and gain experience by working and speaking with other and to enhance my science communication skills through a variety of mediums. Being in a cohort with 28 others with similar research interests would be an amazing experience that would have lifelong benefits. Becoming a Margaret A. Davidson Fellow would be an incredible opportunity that would help me become a leader in estuarine science and help prepare the next generation of coastal scientists.

### Section 3: Project Summary

Predicting marsh bird population response to sea level rise: Providing information for management decisions and a framework for other marsh species

Sea level change has the potential to alter large areas of habitat, which may substantially influence population sizes of many species, and even lead to extinction (Field et al., 2017, Correll et al., 2017, Hunter et al., 2015). Despite this, we have little information on predicted responses of many species to changes in habitat. Two species expected to experience habitat changes as a result of sea level rise are Saltmarsh Sparrow (*Ammospiza caudacuta*, SALS) and Seaside Sparrow (*Ammospiza maritima*, SESP). Both species are also losing essential marsh habitat to anthropogenic forces such as development and marsh restrictions (Correll et al., 2017, and Stutz and Pilkey, 2005). As a result of this habitat loss, both species are listed as Species of Greatest Conservation Need in the NC Wildlife Action Plan (NCWAP, NCWRC 2015), SALS is listed as a primary species of concern in the recently published Salt Marsh Conservation Business Plan, (Salt Marsh Bird Conservation Plan for the Atlantic Coast, 2019) and the USFWS will determine if SALS should be federally listed as Threatened or Endangered in 2023. To develop effective conservation plans, managers seek estimates of population sizes and predictions of how sea level rise could influence habitats and bird populations. We propose to fill these gaps in knowledge through two objectives. In the first objective, we will provide novel population estimates for both species in the southeastern portion of North Carolina (Carteret County–Brunswick County) and better define preferred habitat, habitat utilization, and home range sizes of marsh sparrows during their stationary overwinter period. In the second objective, we will combine information gathered in objective one with modeling to predict how sea level rise would influence habitat types and distributions, and influence population carrying capacity of SALS and SESP. Field data collection would be conducted at 5 field sites, 4 of which are in the North Carolina National Estuarine Research Reserve System: Rachel Carson Reserve (NERRS, Carteret County), Hammock Beach State Park (Onslow County), Masonboro Island (NERRS, New Hanover County), Zeke’s Island (NERRS, New Hanover County), and Bird Island (NERRS, Brunswick County), during 2 field seasons (January–April 2021 and January–April 2022). For objective one, I will use mark-recapture, radio telemetry, and visual surveys to estimate population sizes, calculate home ranges, and describe habitat use. In objective two, I will combine estimates from objective 1 with sea level rise and habitat change models (SLAMM, Sea Level Affecting Marshes Model and MEM, Marsh Equilibrium Models). The models will use existing high-resolution spatial imagery and leverage 2 previous years of data to supplement and validate the data gathered during this study. This research will address 4 *management priorities for the North Carolina Reserve*: i) *Ecosystem Services*—Results would help protect at-risk species and help ensure marsh tourism for wildlife viewing; ii) *Vulnerability*—Novel current population estimates and predicted estimates in response to sea level rise will help the NERRS assess vulnerability for two priority species and provide a framework for understanding the vulnerability of other marsh species of conservation concern. iii) *Habitat Change*—We will assess which areas of NERRS sites are vulnerable to sea level rise and what portion of the vulnerable habitat used by two vulnerable marsh species. This research will also help the NERRS determine best practices for mapping sea level rise and habitat: We will test model sensitivity to a range of spatial and temporal resolution for each data type; iv) *Species and Habitat Restoration/Enhancement*— Research results would assist NC NERRS managers plan future policy and management decisions, including identifying locations that can be restored or enhanced to create future marsh habitat. MEM models compute carbon sequestration so we can use this information to understand the importance of blue carbon sequestration, or lack of carbon sequestration on NERRS sites (Howard et al, 2017, Pendleton et al, 2012, and Mcleod et al, 2011). All of these outcomes will also assist other stakeholders and collaborators, including the NC Wildlife Resources Commission, the USFWS, Audubon, and the tourism industry. We would also perform outreach to community groups and K–12 students and present this research at local meetings and national conferences. An active learning activity will be created with curriculum developers from UNCWs MarineQuest and SciREN to bring to students of all ages with a focus on low income communities that will have an assessment to measure program success.

## Section 4: Project Description

### A. Problem Statement and Background Information

The North Carolina (NC) coast is seeing exceptional environmental, social and economic challenges posed by sea level rise (SLR) (Bin et al. 2007). Many coastal species depend on habitats that are at high risk of degradation and loss from SLR (Hunter et al. 2015). In order to understand how SLR will affect critical wildlife habitats, we must understand habitat needs now and predict habitat changes in the future (Woodrey et al. 2012). These results will help guide effective management, mitigation, and restoration strategies for marsh ecosystems in southeastern NC.

The National Estuarine Research Reserve System (NERRS) is home to many species of waterbirds that are potentially imperiled by SLR and habitat loss. For many vertebrates, including birds, their non-breeding and breeding periods are inextricably linked, and what occurs during one period will have carry-over effects into the next period of life (Marra et al. 2015). Research on population limitation has historically focused on the breeding season (summer), despite recent findings that winter habitat can limit bird populations (Danner et al. 2013). This seasonal bias has created large gaps in knowledge regarding the causes and consequences of population limitation during the non-breeding season (fall/winter/spring; Marra et al. 2015). This dearth of data limits our ability to design effective conservation plans for many species of conservation concern, including two species of marsh sparrows that winter in NC: Saltmarsh Sparrow (*Ammodramus caudatus*, SALS) and Seaside Sparrow (*Ammodramus maritima*, SESP). SALS and SESP are endemic to tidal marshes, which potentially makes them susceptible to population limitation from SLR (Roberts et al. 2019). Saltmarsh Sparrows have experienced population declines of 9% per year since 1998, are on the IUCN's Red List, and are expected to go extinct this century (Correll et al. 2017, Field et al. 2017, BirdLife International, 2018). Seaside Sparrows have also declined in numbers, and one subspecies has gone extinct, with another subspecies listed as Endangered (Post and Greenlaw 2009). The US Fish and Wildlife Service will determine if the Saltmarsh Sparrow should be listed as Threatened or Endangered in 2023 and will request information on the biology of this species to help make the most informed listing decision. The Atlantic Coast Joint Venture has also put SALS in tier A, their highest priority species, in their Salt Marsh Bird Conservation Plan published in December 2019 (Salt Marsh Bird Conservation Plan for the Atlantic Coast, 2019).

Predictive modeling can help us understand how habitats will change in response to SLR, and paired with habitat use data, could provide novel estimates of marsh bird carrying capacity in the future. This approach would provide important information to help set conservation goals and inform design of effective mitigation strategies, including planning for necessary funding and resources. Predictive SLR models have been completed for some individual NC reserve sites (e.g. Rachel Carson Reserve, Garner and Allen 2013) and at the state-level for NC (NC Sea Level Rise Assessment Report 2015), which yielded valuable information. The lack of comprehensive modeling for a large portion of the NC NERR sites with current high-resolution data limits our abilities to predict effects of SLR on habitat changes for species of conservation concern, such as the SALS and SESP, as well as many other animals. It is important to periodically run the models with updated spatial data to compare and track changes over time caused by barrier island shifts and storm events (Passeri et al. 2018). New SLR models would provide additional results for managers, including estimates of carbon that could be released into the atmosphere if marshes are degraded by SLR and an understanding of vulnerable habitat (Pendleton et al. 2012).

This project aims to understand how SLR will impact species of concern on NC NERRS properties to aid in conservation of species and the habitats they use. This research will answer new questions and efficiently leverage data from two years of previous research on SALS and SESP conducted in Raymond Danner's lab at UNCW that was funded by the NC Wildlife Resources Commission and one year of research on the effects of SLR on marsh sparrows funded by the NC Sea Grant/NC Sentinel Site Cooperative.

***This proposal addresses many of the objectives of The National Estuarine Research Reserve System Strategic Plan 2017–2022 including the following:***

***Protecting Places:*** We will create new predictive habitat maps for four reserve sites to understand the effects of loss of habitat on vulnerable species. Through our collaboration with Dr. Eman Ghoneim

(UNCW), we will also have the capability to collect new high-resolution spatial data (i.e. habitat and elevation) with unmanned aircraft, which would benefit our SLR models and be available for other researchers. The predicted sea level rise and habitat change maps will help identify sites for mitigation and restoration. Last, habitat preference and utilization information gathered for SALS and SESP can help identify habitats of high conservation value that are not currently preserved, which is especially important given the rapid decline in SALS populations. The most recent report from the Atlantic Coast Joint Venture has the goal of identifying priority marshes along the Atlantic Flyway ensuring at least 50% of identified priority coastal marshes are restored or enhanced within 10 years, which may include priority areas in or around the NC NERRS (Salt Marsh Bird Conservation Plan for the Atlantic Coast, 2019). Because most species travel across reserve boundaries and exist in metapopulations, it is important to note that results from this study may also lead to effective conservation of properties managed by partners (e.g. Audubon, WRC), and therefore help maintain the populations that occur on NERR properties.

***Applying Science:*** We intend to engage in collaborative research which encompasses university researchers, land managers, and government agencies, which will help address the management needs of the NERRS. This research will also aim to engage graduate students, undergraduates, and community members with field research and volunteer opportunities. This research would also provide materials for new curricula for the NERRS Teachers on the Estuary program.

***Educating Communities:*** This research will be communicated to coastal residents by going out into the community and giving seminars based on this research and through active learning activities for K–12 students. See *Outreach* section for more detail.

***This proposal addresses many of the objectives of North Carolina NERR Reserve Management Needs including the following:***

***Ecosystem Services:*** Bird watching is a large sector of NC tourism revenue in coastal areas. Annually the economic value of birding is \$40 billion nationwide (Carver 2013) and SALS and SESP are trophies for birders to see because they are secretive marsh species; conservation of these and other species could therefore influence local coastal economies.

***Vulnerability:*** NERRS sites are vulnerable for many reasons, many of which are due to anthropogenic forces (Stutz and Pilkey 2005). SLR is expected to continue, and a recent report shows that the rate of sea level rise is more likely to be on the high end of the IPCC's scenarios (IMBIE Team, 2019), which will lead to increased vulnerability of coastal habitats and communities. The vulnerability of coastal habitats to SLR is compounded by human modifications, which create restrictions on marsh migration (Correll et al. 2016). Our use of Sea Level Affecting Marshes Model (SLAMM) and Marsh Equilibrium Models (MEM) will provide valuable assessments of the vulnerability of NERRS sites to SLR and restricted marsh migration.

***Habitat Change:*** We will predict the location and spatial extent of habitats in relation to SLR using SLAMM and MEM models. Use of both models will provide complementary information and allow validation of some model outputs. To help the NERRS assess best practices for modeling and habitat data collection, we will discuss lessons learned and use established approaches for sensitivity analyses to test the sensitivity of the models to data with varying spatial and temporal resolutions (from LiDAR and potentially unmanned aerial vehicles).

***Species and Habitat Restoration/Enhancement:*** Predictive maps from our SLAMM and MEM models will allow managers to identify locations where habitat mitigation and restoration can be completed for vulnerable marsh species. Similarly, the results will be freely available and set the stage for detailed analyses of future changes in habitat that could influence activities on NERRS properties (e.g. wildlife viewing, camping, boating). Although not a direct goal of this study, MEM models compute carbon sequestration, so managers could use this information to understand blue carbon sequestration, or lack of carbon sequestration, on NERRS sites (Howard et al. 2017, Pendleton et al. 2012, and Mcleod et al. 2011).

## **B. Project Approach**

### ***Objectives***

- 1) Provide novel population estimates for winter populations of Saltmarsh and Seaside Sparrows in the southeastern portion of North Carolina (Carteret County–Brunswick County) and better define preferred habitat, habitat utilization, and home range sizes of marsh sparrows.
- 2) Combine information gathered in objective one with modeling to predict how sea level rise would influence habitat types and distributions, and influence population carrying capacity of SALS and SESP, and provide a framework to understand vulnerabilities of other marsh species.

## **Methods**

*Study Sites/Focal Species:* This research will be conducted at 5 field sites in southeastern North Carolina from Carteret County to Brunswick County (listed here from North to South). The Rachel Carson Reserve (NERRS, Carteret County), Hammocks Beach State Park (Onslow County), Masonboro Island (NERRS, New Hanover County), Zeke’s Island (NERRS, New Hanover County), and Bird Island (NERRS, Brunswick County). There are no NERRS sites that have suitable marsh sparrow habitat in the distance between the Rachel Carson Reserve and Masonboro Island, so a NC state park site will be used to fill the gap to ensure population estimates are not skewed for the southern portion of the state. These 5 study sites will be adequate for gathering enough data to estimate population sizes and understand habitat preferences for the southeastern portion of NC. All study sites have been discussed with NERRS and NC State Parks and access to boats and equipment has been discussed and agreed upon with NC NERRS staff. The sites will be broken into two regions, North (Carteret & Onslow Counties) and South (New Hanover & Brunswick Counties), and each region will be studied intensively in each of two years.

SALS and SESP are endemic to marshes and winter along the coast of NC, and there are local breeding populations of Seaside Sparrows in the summer. The winter residents are stationary in our study area from late December to early April (Winder et al. 2012, Lindquist pers. obs.); our field work will be conducted January–early April.

### *Methods for objective 1*

*Mark Recapture:* We will follow the methods of Winder et al. (2012). Briefly, we will capture birds with mist-nets at supratidal habitat during high tides. We will place mist-nets across the width of the habitat and walk through the habitat to flush birds from the vegetation and into the nets. Upon each bird’s capture, we will apply a uniquely numbered leg band or record the number of a previously applied band (bands provided by the USFWS).

*Radio Telemetry:* We will record locations of birds on a near-daily basis at all tide levels during January–March using null peak radio telemetry towers. Although we will focus on low tide to estimate density across the low tide habitat, we will also record locations at other tides to describe how birds track the marsh extent throughout the day. We will vary the time of day that we visit field sites throughout the season in order to capture the entire day and all tide levels. We will attach radio transmitters to the birds’ backs using skin bonding cement. This design does not restrict movement and allows the transmitter to fall off after approximately 1 month which is also the approximate battery life for transmitters of this size. Specifically, we will cut the distal portions of feathers, removing all but the base of the vane using fine scissors. We will then apply skin bonding cement, a small piece of silk, and then superglue the radio transmitter. Transmitters will be manufactured by Biotrack (model Ag376), the batteries will last 27 days, and together application materials, will weigh  $\leq 3\%$  of the birds’ body weight.

We will use triangulation to locate the radio-marked birds following White and Garrott (1990) and Millspaugh and Marzluff (2001). Briefly, we will station two or three researchers along an edge of the research site, separated by at least 100 m. Triangulation is the preferred method of locating the birds because it will allow researchers to find them in locations that are inaccessible to travel by foot or boat, which therefore prevents hand tracking. We will calculate bird locations from paired compass bearings using the R package “sigloc” (Berg 2015). We will analyze location data to provide several results. First, we will estimate home ranges at each tide level. To describe home ranges, we will use kernel density estimates using R package “adehabitatHR” (Calenge 2006). In order to measure distance from high tide capture location to low tide foraging location (which is necessary for density estimation), we will measure distance from capture location to the geographic center of the home range kernel.

*Density Estimates:* Estimates of bird density within habitats are important for assessing conservation value of habitats and are necessary to estimate population sizes at any scale. We do not have density estimates for SALS nor SESP in winter. This gap in knowledge results from the species' daily movements, which poses challenges for estimating density. Specifically, SALS and SESP sparrows spread out into the marsh at low tide and congregate in small patches of exposed vegetation at high tide (e.g. Winder et al. 2012). We expect that densities (and therefore population sizes) of these sparrows are limited by low-tide habitat availability. This expectation is based on the fact that both species primarily forage for insects and seeds in mud that is exposed below the high tide line, and that food availability limits population densities of a related species (swamp sparrow, *Melospiza georgiana*: Danner et al. 2013). This suggests that population sizes should be estimated from the extent of low tide habitat. However, it has been difficult to estimate densities of these marsh sparrows at low tide in winter because they occur in low density when spread across the marsh, which results in small sample sizes.

We have developed a novel approach that will allow us to estimate sparrow densities in low tide habitats, and therefore estimate population sizes. Specifically, we will combine mark-recapture data with radio-tracking data. We will estimate a detection function based on radio-telemetry data, which will allow us to scale up our local abundance estimates (from mark-recapture) to account for individuals that roost in other locations at high tide. We will then locate these marked birds with radio telemetry to measure the distances that they travel into the low tide marsh to forage. We expect a negative relationship between the distance from the capture location and the proportion of tagged birds that forage at that particular distance. This pattern would reflect birds farther away going to other locations at high tide. With the radio telemetry data, we will calculate a detection function, which will allow us to correct our population size estimates from mark-recapture and estimate the abundance of birds in our study areas. We will conduct all analyses using R statistical software (R Core Team 2018), including novel code along with the R package "mrds" (Laake et al. 2017). To estimate density, we will divide abundance by the area bounded by the farthest distance that a marked bird travels to its foraging location at low-tide and habitat boundaries (e.g. a beach or open water).

*Visual Surveys:* We have created a novel method to perform visual surveys for secretive marsh sparrows during the non-breeding period. We use long ropes held between two or more individuals to brush the marsh grass and flush the birds up and briefly out of the grass. While the bird flies, trained observers will identify the species. Since mark-recapture only focuses on one area on each island, visual surveys can help refine population estimates for sites outside of the netting locations.

#### *Methods for Objective 2:*

For my second objective, we will use computer modeling to predict the effect of SLR on habitat change at the study sites. For this portion of the project, we will collaborate with Dr. Eman Ghoneim, who is a Professor of Geography in the Earth and Ocean Sciences Department at UNCW. Dr. Ghoneim's research focuses on physical geography using remote sensing, GIS, and geomorphology in coastal ecosystems. Her expertise will ensure that we are running the models properly with the most accurate spatial data available. Her lab owns drones so if spatial data are not available, we will be able to use her resources to gather data. Dr. Raymond Danner has expertise with population estimation and spatial analysis and simulation modeling including testing, design optimization and sensitivity analyses.

*SLAMM:* We will use SLAMM (Sea Level Affecting Marshes Model) version 6.7 to model how SLR will affect marsh habitat (Clough et al. 2016) at our 5 study sites. We plan to use SLAMM 6.7 with data from NOAA's Tides and Currents database, and local water level monitoring stations to model SLR across coastal NC. SLAMM 6.7 allows incorporation of LiDAR-based regional marsh elevations into the models (Clough et al. 2016, Propato et al. 2018), which we will obtain from NOAA's Digital Coast database. LiDAR data will be ground truthed to ensure the most accurate elevation levels. We will use sensitivity analyses to assess accuracy with different elevation models to understand the most appropriate models for NERRS sites. In the SLAMM model, we will parameterize elevation, accretion and erosion, habitat classifications, overwash events, and 3 IPCC emission scenarios (RCP 2.6, 6.0 and 8.5).

*MEM:* We will also run Marsh Equilibrium Models (MEM) version 5.4 created by Dr. Jim Morris University of South Carolina. We will run MEM models to predict marsh responses to sea-level rise and



compute carbon sequestration at the same spatial and temporal scales investigated in the SLAMM models. MEM models have inputs such as suspended sediment and biomass data and can be used as a comparison for the SLAMM models.

*End Users:* NOAA/NERRS are the primary intended end users of this research project. The NC WRC and the USFWS can use population estimates to aid in management and federal listing decisions as Threatened or Endangered for SALS and SESP. The ACJV can also use this information in the Salt Marsh Bird Conservation Plan. NC State Parks may also benefit from population estimations of SALS and SESP, as well as SLR modeling, at Hammocks Beach. Any other land managers that focus on marshes can use this information to help identify sparrow habitat and where to focus habitat acquisition for conservation.

### C. Expected Outcomes

*Objective 1:* The project outcomes would be population estimates of SALS and SESP for the southeastern portion of NC (Carteret County–Brunswick County). This outcome would be beneficial for stakeholders identified in *End Users*. Another outcome would be fine detail habitat preferences and an understanding of habitat utilization, which could help the NERRS prioritize management actions in locations of ideal marsh sparrow habitat. Home range sizes and habitat needs will be essential to determine the effects of SLR on populations in objective 2. With this objective we can also educate the NERRS staff on marsh bird identification, capture, and habitat preferences.

*Objective 2:* Project outcomes will include predictions of SALS and SESP population sizes, as well as habitat location and extent, under a variety of scenarios of SLR. The product from this objective, will be SLAMM and MEM model outputs that the NERRS can use to understand how their reserves are going to be affected by sea level rise and use them as a framework for management decisions. All data will be publicly available, thus allowing scientist and managers to study SLR influences on other NERRS properties.

*Evaluation/Dissemination:* This project will be evaluated for success by writing a final report and 1–2 manuscripts for publication. It will also be evaluated based on if data collected is used by the *End Users* identified above. We will present at meetings for stakeholders such as the NC Waterbirds meeting, NC Coastal Conference, Cape Fear Arch/Onslow Bight Joint meetings, and NERR annual meetings and present the findings at conferences such as the American Ornithological Society, Association of Southeastern Biologists and Wilson’s Ornithological Society. The information will be disseminated to a mix of land managers, academics, and government officials.

*Outreach:* An important part of this project is creating outreach and active learning curricula for a mix of audiences from K-12 students to community members. There are great resources both at UNCW and other science education communities that we would use to help create engaging experiences where success can be measured. MarineQuest is a science learning program hosted at UNCW for K–12 students and they are a great resource for hosting active learning programs, and for assisting in curriculum development. The Danner lab has worked with MarineQuest previously for outreach. We would also attend the SciREN 2021 workshop in Beaufort, NC to refine the curriculum created. After working with these groups to create active learning experiences, we would then present the program at MarineQuest summer camps and public schools with a focus on low income areas in and around southeastern NC. We would create an assessment to measure the effectiveness of the learning experience. We will also do outreach at local community meetings such as Audubon NC, Sierra Club, local governmental policy meetings and to present our research to members of the community.

### D. Milestone Schedule

Season (Academic semester)	Fall 2020	Spring 2021	Summer 2021	Fall 2021	Spring 2022	Summer 2022	Fall 2022
Planning/Course Work							
Winter Field Work							
SLR Modeling							
Final Report							

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## RESUME

**Marae C. Lindquist**

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### ***Education and Professional Experience***

Fall 2018–present **Ph.D. Student, Department of Biology and Marine Biology**, University of North Carolina at Wilmington, Advisor: Dr. Raymond Danner. Project: Use radio telemetry to characterize movements of individual birds throughout the day and tidal cycle, as well as estimate home range sizes; combine mark-recapture data and movement data to estimate density; estimate abundance in the study areas.

2011–2014 **B.S. Biology (Concentration Ecology & Evolutionary Studies)** Appalachian State University. Advisor: Dr. Ray Williams. Capstone Project: Aphid Colonization of multiple species and genotypes of *Solidago* spp. Beta Beta Honors society, Magna Cum Laude

Spring 2015–Fall 2015 **Recreation Assistant**, Halyburton Park, Wilmington, NC

May 2012–August 2012 **Biological Science Intern**, U.S. Department of Agriculture, Fort Pierce Florida

### ***Fellowships and Awards***

2019	NC Sea Grant/NC Sentinel Site Joint Cooperative Fellowship	\$9,999
2018	Dr. James F. and Frances B. Parnell Fellowship	\$2,029
2018	New Scholar Award for Department of Biology and Marine Biology University of North Carolina, at Wilmington	\$1,000
2015	Meritorious Senior Award Appalachian State University Biology Department	

### ***Agency Technical Reports***

2019 Danner, R., Buckland, E., Lindquist, M., Zuluaga, J. Interim Report 2: The winter population biology of saltmarsh and seaside sparrows in southeastern North Carolina: density, abundance, space use, survival, and migratory status. University of North Carolina Wilmington, NC

2019 Danner, R., Buckland, E., Lindquist, M., Zuluaga, J. Interim Report 1: The winter population biology of saltmarsh and seaside sparrows in southeastern North Carolina: density, abundance, space use, survival, and migratory status. University of North Carolina Wilmington, NC

### ***Conference/Meeting Presentations***

2019 Lindquist, M.C., Danner R.M. 2019. Predicting the effects of sea level rise on marsh birds of conservation concern in coastal North Carolina. Meeting of the NC Sentinel Site Cooperative, Core Management Team. Beaufort, NC.

2019 Lindquist, M.C, Danner R.M. Predicting the effects of sea level rise on marsh birds of conservation concern in coastal North Carolina. 3rd NC Sea Grant Coastal Conference, Wilmington NC

2019 Lindquist, M.C, Buckland, E.L, Carpenter, J.P., Danner R.M., Chasing the tides: Overwinter intertidal movements of Saltmarsh and Seaside Sparrows. 2019 joint

	meeting of the Association of Field Ornithologists and the Wilson Ornithological Society. Cape May, NJ
2019	Lindquist, M.C, Buckland, E.L, Carpenter, J.P., Danner R.M., Characterizing movements of saltmarsh and seaside sparrows on wintering grounds using radio telemetry. 137 <sup>th</sup> American Ornithology Meeting, Anchorage, AK
2019	Lindquist, M.C., Buckland E.L., The winter population biology of saltmarsh and seaside sparrows in southeastern North Carolina: density, abundance, space use, survival, and migratory status. NC Waterbird Management Committee Meeting, Swansboro, NC
2015	Lindquist, M.C., Aphid Colonization of multiple species and genotypes of <i>Solidago</i> spp. 76 <sup>th</sup> Association of Southeastern Biologist, Chattanooga, TN

### ***Membership in Scientific Societies***

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American Ornithological Society, Wilson Ornithological Society, Association of Field Ornithologist

### ***Teaching***

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2019	Thermal Biology Outreach Program, Marine Quest and Ashley High School
2018–present	Teaching Assistant, Ecology Lab, UNCW (24 students per class)
2015	Bug Collecting class at Halyburton Park, kids ages 5-10

### ***Mentorship/Research Assistants***

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2019-2020	Sofia Campuzano (BS, Biology) Marsh sparrow research
2019-2020	Cassidy Mason (BS, Environmental Science) Sea level rise modeling
2018–present	Zuluaga, Juan (BS, Biology) Saltmarsh and seaside sparrow research

### ***Relevant Education/Certifications***

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2019 UNCW Center for Marine Science boat operator course  
 2018 CITI Responsible conduct of research  
 2018 NC Boater education course  
 2018 City of Wilmington, Foundations of Management Training  
 2017 City of Wilmington, Foundation of Supervision Training  
 2017 CPR/First Aid certification  
 2015 Effective Teacher Training, CFCC  
 2009 PADI Scuba certification

### ***Relevant Coursework***

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2019 Introduction to Geographic Information Systems  
 2019 Organismal Function and Global Climate Change  
 2019 Directed Independent Study: Geographical Information Systems  
 2019 Directed Independent Study: Ornithological Field Methods  
 2019 Directed Independent Study: R Statistical Software  
 2018 Advanced topics in Ornithology

### ***Knowledge of Specialized Software***

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R statistical software  
 ArcGIS 10.7

Data Management Plan

Marae Lindquist

PhD Student

University of North Carolina Wilmington

Department of Biology and Marine Biology

Mcl6280@uncw.edu

(910) 465-0446

Predicting marsh bird population response to sea level rise: Providing information for management decisions and a framework for other marsh species implemented by Marae Lindquist, will generate environmental data and information, including sea level rise estimates for coastal North Carolina, and marsh sparrow population estimates using SLAMM version 6.7 model and MEM version 5.4. Data for the models will be collected from public water level data such as NOAA tides and currents, and other water level monitoring stations. Datasets will provide water level data from sites that collect water levels every 6 minutes or less as in accordance with NOAA standards. Data will be pooled and collected by Marae Lindquist according to the SLAMM model created by Jim Morris and Warren Pinnacle Consulting, Inc, and MEM created by Dr. Jim Morris University of South Carolina, and stored at the University of North Carolina Wilmington. At this time, it is unknown the total volume of data that will be collected. All data collected on banded birds (SALS and SESP) will be submitted to the Bird Banding Laboratory (USGS). Contact Marae Lindquist at mcl6280@uncw.edu or Dr. Raymond Danner at dannerr@uncw.edu for more information or to make a data request. All data will be visible, accessible and independently understandable to users within and no later than two years. Manuscripts will be made public and be submitted to the NOAA Institutional Repository after acceptance and not later than upon publication. In the past Dr. Danner has shared similar data through a former Sea Grant report, online data repositories including Dryad, Dr. Danner's academic webpage, supplemental data files in scientific papers, data files shared on the Smithsonian Migratory Bird Center's page, through GitHub, and Comprehensive R Archive Network (CRAN). All future sub-awardees not identified in this plan will as a condition of their contract acceptance of this data sharing plan. Any additional data sharing stipulations for future sub-awardees may be outlined at that time and described in their contract.

#### NEPA Statement

We do not anticipate that this research will be restricted because of NEPA requirements. If funded we will answer NEPA questions 1-13 in full and we are happy to answer any other questions regarding to NEPA.

## Budget Narrative

### A. Personnel

Position Title & Name	Salary	% of Time	No. of months	Summer Salary	% of Time	No. of months	Total per year	Project total
PI, Marae Lindquist	\$10,500/ semester	100%	4.5	\$2,720/ month	100%	3	\$18,660	\$37,320
Field Technician	\$7,000/ 3.5 months	100%	3.5	-	-	-	\$7000	\$14,000

#### Justifications:

**Principal Investigator- Marae Lindquist:** The position is for the lead investigator on the project, this position is the person leading the work being done, responsible for performing field work, coordinating the project and the other personnel and volunteers on the project. Responsible for gathering, analyzing, and interpreting the data and creating reports to be submitted to NOAA. This will pay for stipend for the Spring Semesters (January–May), summer stipend (May–July). The monthly salary during the semester is \$2,333 a month for a total of \$10,500 (semester) and monthly salary for summer is \$2,720 for a total of \$8,160. For each year total with academic year and summer stipend the PI will be paid \$18,660 per year.

**Field Technician:** This position is to assist the PI with field work. This research is field intensive and uses ornithological field methods that requires at least two skilled bird handlers to safely and successfully complete. This position would also help the technicians career opportunities by learning essential ornithological field techniques and other technical and software skills. This technician position is for the season need for field work which will be January–mid April. The field technician will be paid a monthly salary of \$2,000 for a total of 3.5 months for a yearly salary of \$7,000. The field technician will have to be hired each year.

### B. Fringe Benefits

Fringe benefit	Fringe Rate	Academic year	Summer Stipend	Totals per year	Project total
PI- PhD Student	8.65%	\$908	\$706	\$1614	\$3,228
Field Technician	8.65%	\$606	-	\$606	\$1,212

Justification: UNCW requires a fringe rate of 8.65% for graduate students and technicians per year.

### C. Travel

#### Domestic travel

Travel Description	Number of trips	Miles per trip	Mile Reimbursement	Total Per Year
Daily travel to field site	60	10	\$5	\$327
Travel from UNCW to field sites	3	96	\$52	\$157
Conference and workshop travel				\$7,000
Total travel cost per year				\$7,484
Total project travel cost				\$14,968

Justification: The Margaret A. Davidson Fellowship specifies \$7,000 for travel for the fellowship related travel to meeting specified by the NERR and one scientific conference determined by the fellow to present the research completed for the fellowship. For mileage reimbursement this is for driving a personal vehicle to and from field sites, including mileage for 3 longer trip from Wilmington NC, to Beaufort, NC per year. One of the trips to Beaufort, NC would be to attend the SciREN workshop for science education, the other two would be for field work. No international travel is required for this fellowship.

International Travel- None

D. Equipment  
None

E. Supplies

Field Supplies	Quantity	Price per unit	Total Price Yr 1	Total Price Yr 2	Project total
Biotrack pip AG376 Radio Tag	18	\$160	\$2,880	\$2,880	\$5,760
Miscellaneous field supplies	1		\$116	\$16	\$132

Justification: Biotrack radio tags are required to complete the radio telemetry and density estimates which is a crucial element of this project these tags have a lifespan of about 1 month. We also may have some unseen cost or field supplies break which justifies the miscellaneous field supply cost. Total cost of supplies for two years is \$5829

F. Contractual  
None

G. Construction  
None

H. Other

Health insurance
\$2,640/year 1
\$2,740/year 2
\$5,380/project total

Justification: Health insurance is required for all students enrolled in UNCW and the annual cost is expected to increase by \$100 per year.



I. Total Direct Charges

Total Direct Charges	
A. Personnel	\$51,320
B. Fringe	\$4,439
C. Travel	\$14,968
D. Equipment	0
E. Supplies	\$5,892
F. Contractual	0
G. Construction	0
H. Other	\$5,380
Total	\$81,999

J. Indirect Charges

The rate is 49% and is computed on the following direct cost base \$41,000/year

Project Total \$40,180

Total Direct Charges	Cost
A. Personnel	\$51,320
B. Fringe	\$4,439
C. Travel	\$14,968
D. Equipment	0
E. Supplies	\$5,892
F. Contractual	0
G. Construction	0
H. Other	\$5,380
Total indirect changes	\$40,180

K. Totals Direct and Indirect

Total Direct and Indirect per year: \$61,089

Total Project Cost: \$122,179

L. Cost Share or Match

None

## Permits

We have or can promptly acquire all necessary permits to perform this research. Dr. Danner holds a Master Bird Banding Permit from the USGS Bird Banding Lab (permit #24054) and is authorized to band both saltmarsh and seaside sparrows, with special authorization to use mist nets and audio lures. Dr. Danner also received necessary Wildlife Collection License permits from the NCWRC (permit #18-SC01307). All parties have also received IACUC approval (protocol # A 1819-004). Permission for research on National Estuarine Research Reserve System (NERRS) properties was granted by the NC NERRS (Dr. Brandon Puckett and site manager Hope Sutton). Work on NC State Parks has been discussed with Ed Corey.

## References

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## Application

Application ID: 2851732

Applicant: University of North Carolina at Wilmington

Project Title: Predicting marsh bird population response to sea level rise: providing information for management decisions and a framework for other marsh species

Project Period: 09/01/2020 - 08/31/2022

Total Amount Proposed: \$122,179.00

Federal Amount Requested: \$122,179.00

Fiscal Year of Federal Funding Requested: 2020

Principal Investigators / Project Directors:

### Reviewer 103

#### Scoring Summary

Total Score: 96

#### Scoring Details

Score	Range	Criterion
25	0 - 25	Importance/Relevance and Applicability of Proposal to the Program Goals
22	0 - 25	Technical/Scientific Merit
20	0 - 20	Overall Qualification of Applicant
9	0 - 10	Project Costs
15	0 - 15	Outreach and Education
5	0 - 5	Data Management Plan Technical Soundness

#### Review Criteria

##### Importance/Relevance and Applicability of Proposal to the Program Goals

This criterion ascertains whether there is intrinsic value in the proposed work and/or relevance to NOAA, federal, regional, state, or local activities.

For the Margaret A. Davidson Graduate Fellowship, this refers to addressing the priority management needs identified by the reserves (<https://coast.noaa.gov/nerrs/research/davidson-fellowship.html>). Does the proposed work relate to at least one appropriate reserve management need? Does the project demonstrate a sufficient understanding of the relevant coastal management issue? Does the project take an approach that is important to address a specific priority management need?

Comments (Required):

Four different management priorities are addressed by this project, along with clear connections of the proposed research to those priorities.

##### Technical/Scientific Merit

This criterion assesses whether the approach is technically sound, if the methods are

appropriate, and whether there are clear project goals and objectives.

Is the approach appropriate to address the reserve need and are the stated goals and objectives worthy and achievable within the proposed time-frame? Does the proposed approach incorporate sound science, scientific, and/or technical advancements in the design and implementation of the proposed work? Are the project milestones feasible and are sufficient guidance, support, time, and resources available for the methods proposed to conduct the proposed research?

Comments (Required):

The proposal does have clear goals that seem achievable if all goes well. The methods are also innovative and novel, especially the use of a detection function to scale up local abundance measures from capture-recapture data. My only concern is that the sample sizes (i.e., number of radioed birds) appear to be small ( $n=18$  each year for the 2 species combined). Further, some birds may die or permanently emigrate, further reducing an already small sample size. Perhaps additional funds exist elsewhere for more transmitters, but I saw no indication of this in the proposal, nor of estimates of required sample sizes, which I suspect are large. This problem is fixable, though, with a small further investment of resources, so I don't see it as a fatal flaw. Also, the telemetry data recording system is innovative but there is no indication that it has been used successfully in the past. I worry because salt marsh systems are brutal on electronics.

### **Overall Qualification of Applicant**

This criterion ascertains whether the applicant possesses the necessary education, experience, training, facilities, and administrative resources to accomplish the project.

Has the applicant articulated significant interest in professional development as part of the fellowship? Does the applicant have the educational background and fortitude needed to successfully conduct this project? Does the application, including letters of support, indicate that the student has the potential to be successful? Do the letters from the faculty advisor demonstrate support for the fellowship?

Comments (Required):

All recommendations of the student are glowing. Her credentials are excellent and appears to have a strong work ethic and interest in conservation science. Her mentor is equally enthusiastic and guarantees the active and serious involvement of other essential colleagues.

### **Project Costs**

This criterion evaluates the budget to determine if it is realistic and commensurate with the project needs and time-frame.

Is the budget request reasonable and does the applicant justify the proposed budget request? Is the allocation sufficient to cover the travel requirements of the program? Is the allocation sufficient to provide the resources needed to conduct the project?

Comments (Required):

The budget is reasonable in all aspects except for the funds devoted to transmitters, in that I think there should be more, as I indicated above.

### **Outreach and Education**

This criterion assesses whether the project provides a focused and effective education and outreach strategy regarding NOAA's mission to protect the Nation's natural resources.

Does the project identify potential end-users? Does the project propose a collaborative approach to incorporate the appropriate end-users input into the outcomes and any products? Does the applicant demonstrate knowledge of the target audience? Will the project outputs meet the identified end user needs?

Comments (Required):

All the appropriate end-users I can think of are identified. In addition to NOAA/NERRS, the Atlantic Coast Joint Venture and USFWS are included. The information that this study will provide will be important to both entities. The ACJV will make direct use of density estimates and other data, and one or both of these species may be federally listed in the near future.

### **Data Management Plan Technical Soundness**

This criterion assesses whether the Data Management Plan, if required, ensures that the data collected and/or created will be made available to general users in a timely manner free of charge, or at minimal cost.

Project includes a data management plan that ensures that environmental data collected as part of the project will be shared among the fellow, university faculty sponsor, and reserve staff prior to the conclusion of the fellowship. The data management plan should meet the requirement to be visible, accessible, and independently understandable to users in a timely fashion (typically within two years).

Comments (Required):

This appears to be adequate and appropriate. Overall comments: The proposed study is innovative and potentially valuable to numerous end-users, and explores new ground by measuring home ranges under different tidal conditions, then using those data to estimate sparrow density in a notoriously difficult system. The student's credentials and commitment to the project are strong, as are the major advisor's. Four different management needs identified by the North Carolina NERR are addressed by this project, which is outstanding. My main reservation is with the proposed sample size (<10 per

species per year) for radioed birds. This seems small and there is no assessment of required sample size in the proposal. Also, it is unclear if the recording system for the telemetry data has been tested before in saltwater conditions. My reservations about the budget reflect the sample size issue.

## **Reviewer 102**

### **Scoring Summary**

Total Score: 97

#### **Scoring Details**

<b>Score</b>	<b>Range</b>	<b>Criterion</b>
25	0 - 25	Importance/Relevance and Applicability of Proposal to the Program Goals
23	0 - 25	Technical/Scientific Merit
20	0 - 20	Overall Qualification of Applicant
10	0 - 10	Project Costs
14	0 - 15	Outreach and Education
5	0 - 5	Data Management Plan Technical Soundness

### **Review Criteria**

#### **Importance/Relevance and Applicability of Proposal to the Program Goals**

This criterion ascertains whether there is intrinsic value in the proposed work and/or relevance to NOAA, federal, regional, state, or local activities.

For the Margaret A. Davidson Graduate Fellowship, this refers to addressing the priority management needs identified by the reserves (<https://coast.noaa.gov/nerrs/research/davidson-fellowship.html>). Does the proposed work relate to at least one appropriate reserve management need? Does the project demonstrate a sufficient understanding of the relevant coastal management issue? Does the project take an approach that is important to address a specific priority management need?

#### **Comments (Required):**

I believe there is intrinsic and timely conservation value in the proposed work at local and regional scales. There is very little information about these species on their overwintering range, and even less information about the response of the populations to sea level rise and the associated changes likely to occur in the habitats they depend on. I believe this project demonstrates a very good understanding of the relevant coastal management and species conservation issues. Furthermore, I believe it will fill important knowledge gaps that will inform the understanding of overwintering habitat, population dynamics, and future restoration and resilience priorities within the NERRs and other coastal marshes where these species occur.

#### **Technical/Scientific Merit**

This criterion assesses whether the approach is technically sound, if the methods are



appropriate, and whether there are clear project goals and objectives.

Is the approach appropriate to address the reserve need and are the stated goals and objectives worthy and achievable within the proposed time-frame? Does the proposed approach incorporate sound science, scientific, and/or technical advancements in the design and implementation of the proposed work? Are the project milestones feasible and are sufficient guidance, support, time, and resources available for the methods proposed to conduct the proposed research?

Comments (Required):

I believe the technical and scientific approaches are appropriate on all accounts. One challenge I see is the validation of SLAMM as the best model for sea level rise. While I am not an expert on SLAMM, these marshes receive periodic pulses of sediment and this sediment could effect the rate of vertical accretion in the marsh study sites. One additional issue could be the ability to walk through the study site marshes at low tide (visual surveys). Some marshes within the study are have very soft mud and walking through these marshes is a challenge; others are quite firm and walking would not likely present a problem.

### **Overall Qualification of Applicant**

This criterion ascertains whether the applicant possesses the necessary education, experience, training, facilities, and administrative resources to accomplish the project.

Has the applicant articulated significant interest in professional development as part of the fellowship? Does the applicant have the educational background and fortitude needed to successfully conduct this project? Does the application, including letters of support, indicate that the student has the potential to be successful? Do the letters from the faculty advisor demonstrate support for the fellowship?

Comments (Required):

I believe the applicant is very well qualified to implement this project and I also believe she is supported by an excellent institution.

### **Project Costs**

This criterion evaluates the budget to determine if it is realistic and commensurate with the project needs and time-frame.

Is the budget request reasonable and does the applicant justify the proposed budget request? Is the allocation sufficient to cover the travel requirements of the program? Is the allocation sufficient to provide the resources needed to conduct the project?

Comments (Required):

The costs seem both realistic and in line with the scope of the work and time frame.

### **Outreach and Education**

This criterion assesses whether the project provides a focused and effective education and outreach strategy regarding NOAA's mission to protect the Nation's natural resources.

Does the project identify potential end-users? Does the project propose a collaborative approach to incorporate the appropriate end-users input into the outcomes and any products? Does the applicant demonstrate knowledge of the target audience? Will the project outputs meet the identified end user needs?

Comments (Required):

The project identifies a suite potential end users. I believe there will be additional end users. I am unsure how tourism will benefit in a meaningful way.

### **Data Management Plan Technical Soundness**

This criterion assesses whether the Data Management Plan, if required, ensures that the data collected and/or created will be made available to general users in a timely manner free of charge, or at minimal cost.

Project includes a data management plan that ensures that environmental data collected as part of the project will be shared among the fellow, university faculty sponsor, and reserve staff prior to the conclusion of the fellowship. The data management plan should meet the requirement to be visible, accessible, and independently understandable to users in a timely fashion (typically within two years).

Comments (Required):

The data management plan appears adequate and appropriate for this study.

### **Reviewer 104**

#### **Scoring Summary**

Total Score: 88

#### **Scoring Details**

<b>Score</b>	<b>Range</b>	<b>Criterion</b>
21	0 - 25	Importance/Relevance and Applicability of Proposal to the Program Goals
22	0 - 25	Technical/Scientific Merit
19	0 - 20	Overall Qualification of Applicant
10	0 - 10	Project Costs
12	0 - 15	Outreach and Education
4	0 - 5	Data Management Plan Technical Soundness

## Review Criteria

### Importance/Relevance and Applicability of Proposal to the Program Goals

This criterion ascertains whether there is intrinsic value in the proposed work and/or relevance to NOAA, federal, regional, state, or local activities.

For the Margaret A. Davidson Graduate Fellowship, this refers to addressing the priority management needs identified by the reserves (<https://coast.noaa.gov/nerrs/research/davidson-fellowship.html>). Does the proposed work relate to at least one appropriate reserve management need? Does the project demonstrate a sufficient understanding of the relevant coastal management issue? Does the project take an approach that is important to address a specific priority management need?

#### Comments (Required):

This proposed work addresses four priority management issues noted for the North Carolina Reserves. These include i) Ecosystem Services, ii) Vulnerability, iii) Habitat Change, and iv) Species and Habitat Restoration/Enhancement. While it does address Ecosystem Services, I consider that a minor connection that is not critical to this work. However, providing critical data to address Reserve vulnerability, habitat change, and species enhancement is of the highest priority. The student does an excellent job of linking her proposed research on two species of imperiled passerine marsh birds to the broader ecological understanding and conservation of tidal marshes across coastal North Carolina. The multi-faceted approach of the work is built in a hierarchical framework building from species-specific ecological data which is then linked directly to sea level rise through two tried-and-true specific modeling approaches. Further, the proposed outreach components of the work are clearly effective approaches and incorporating into existing programs help to leverage previous education and outreach efforts. However, I see two weaknesses in the proposal, although neither should be considered catastrophic; they can both be easily remedied quite easily. First, from a technical perspective it is unclear exactly how the bird density data will be directly linked in a meaningful way to the SLAMM and MEM efforts. While these models provide complimentary outputs regarding the effects of sea level rise, the student failed to explicitly explain how these data would be used to evaluate future impacts of predicted sea level rise. Are they planning to simply look at the percent change in a given habitat type and then using their density estimates simply correct up or down the predicted population effect? Or are they going to use their bird habitat use and density data in a more formal modeling approach, such as using dynamic rather than static modeling approaches, given the dynamic nature of coastal wetlands. Further, will their models address issues relating to the degree to which the ecological relationships they are investigating are known to be causative? These are issues which need to be addressed at the outset of their modeling effort before they begin collecting data that may or may not directly meet the data needs of their models. Second, while the student did an excellent job of discussing their education and outreach activities through the UNCW science education programs, details were lacking regarding how their results will be transferred to the stakeholders such as natural resource and coastal zone land managers. It would be prudent for the student to meet specifically

with Reserve staff, including the Research Coordinator, the Manager, and Coastal Training Program Coordinator to specifically identify opportunities to directly engage with this end-user community. While scientific publications are one metric of “success” in the academic community, in this instance it is also critically important to engage with and discuss the project with land managers throughout every phase of the project.

### **Technical/Scientific Merit**

This criterion assesses whether the approach is technically sound, if the methods are appropriate, and whether there are clear project goals and objectives.

Is the approach appropriate to address the reserve need and are the stated goals and objectives worthy and achievable within the proposed time-frame? Does the proposed approach incorporate sound science, scientific, and/or technical advancements in the design and implementation of the proposed work? Are the project milestones feasible and are sufficient guidance, support, time, and resources available for the methods proposed to conduct the proposed research?

### **Comments (Required):**

This proposal clearly states the project objectives and makes a clear and logical argument for the connections of their field data to their end product of evaluating the efforts of predicted sea level rise on two passerine marsh birds. The methods outlined in the proposed work are well documented with primary literature and are methods that have been successfully used across the South Atlantic coastal region. Analytical methods and approaches for determining absolute densities of sparrows are consistent with current approaches in the field and are designed to estimate a detection probability, which is critical to making reliable and precise bird population estimates via correcting raw count data to reflect differences across habitats or study locations based on a myriad of factors that could affect one’s ability to detect an individual bird. The methods for predicting future sea level rise effects are commonly accepted approaches. However, one concern I have is the scale at which field data used to parameterize the model matching the scale of the SLAMM modeling approach. SLAMM models were developed to look at vegetation changes at a more regional scale rather than a management unit. However, as long as data are available at a scale there should be little concern for the inference to be made from the modeling efforts. A second note of caution is the availability of local scale TSS, or total suspended solids data. While regional or broad-scale data are often used in the SLAMM efforts, recent evaluation of the importance of scale issues relating to TSS indicate that using more regional data can strongly bias prediction of future habitat change using SLAMM. Having conducted prior research at these study sites, it appears highly likely that this work will be successful and yield rigorous and useful results. Further, the milestones and timeline, as well as the budget, are reasonable and will likely result in the collection of data which will address the objectives for this proposed work.

### **Overall Qualification of Applicant**

This criterion ascertains whether the applicant possesses the necessary education, experience, training, facilities, and administrative resources to accomplish the project.

Has the applicant articulated significant interest in professional development as part of the fellowship? Does the applicant have the educational background and fortitude needed to successfully conduct this project? Does the application, including letters of support, indicate that the student has the potential to be successful? Do the letters from the faculty advisor demonstrate support for the fellowship?

**Comments (Required):**

It is clear from the student's Curriculum Vitae that they have the experience, expertise and drive to complete the proposed work. Further, it is clear that her academic advisors, her home institution, and the major state-based land management agency support this work both from a logistical and financial perspective. In addition, the student has clearly been actively engaged in her research, making several presentations in 2019 at both regional and national scientific conferences. She has also mentored or is currently mentoring three undergraduate field technicians, who are gaining invaluable field experience and an appreciation for what it means to do field ecology and conservation biology.

**Project Costs**

This criterion evaluates the budget to determine if it is realistic and commensurate with the project needs and time-frame.

Is the budget request reasonable and does the applicant justify the proposed budget request? Is the allocation sufficient to cover the travel requirements of the program? Is the allocation sufficient to provide the resources needed to conduct the project?

**Comments (Required):**

The proposed budget is reasonable and adequate to support this project. The student's advisor, Dr. Danner, has much of the necessary field supplies through his previous research so the budget reflects resources necessary for telemetry work and travel support to and from the field study sites.

**Outreach and Education**

This criterion assesses whether the project provides a focused and effective education and outreach strategy regarding NOAA's mission to protect the Nation's natural resources.

Does the project identify potential end-users? Does the project propose a collaborative approach to incorporate the appropriate end-users input into the outcomes and any products? Does the applicant demonstrate knowledge of the target audience? Will the project outputs meet the identified end user needs?

**Comments (Required):**

This proposal outlines a logical and fairly complete strategy for sharing project results

with a variety of audiences. Much of the proposed focus on education and outreach activities through the UNCW science education programs, which are an important target audience. However, given the premise for the Margaret A. Davidson fellowship, there was a lack of a detailed strategy regarding how their results will be transferred to the stakeholders such as natural resource and coastal zone land managers as well as comments regarding how the student will work across the Reserve staff. It would be prudent for the student to meet specifically with Reserve staff, including the Research Coordinator, the Manager, and Coastal Training Program Coordinator to specifically identify opportunities to directly engage with their respective programs. Further, the Reserve staff will also be able to provide direct contacts and connections with the land management community in coastal North Carolina.

### **Data Management Plan Technical Soundness**

This criterion assesses whether the Data Management Plan, if required, ensures that the data collected and/or created will be made available to general users in a timely manner free of charge, or at minimal cost.

Project includes a data management plan that ensures that environmental data collected as part of the project will be shared among the fellow, university faculty sponsor, and reserve staff prior to the conclusion of the fellowship. The data management plan should meet the requirement to be visible, accessible, and independently understandable to users in a timely fashion (typically within two years).

### **Comments (Required):**

The proposed data management plan is fairly typical and straight-forward. It adequately allows data to be visible, accessible, and independently understandable. One missing element however, is any mention of the use of meta-data standards. While data management, storage and archiving are a critical component of good data management, the use of standard metadata formats are critical for putting these data into context and provide details regarding field methods, data descriptions, study site descriptions, as well as notes regarding events and conditions which could have impacted results in a given season or year.

**FY2020 Margaret A. Davidson Graduate Fellowship**  
**National Estuarine Research Reserve**  
**Panel Summary**

Please insert the final panel scores for each applicant in the summary table below. Applicants are ranked by the average panel score. In the event of a tie, the comments will be used to determine the selection. These comments will be particularly important when justifying a funding recommendation that has a lower merit review score. NOAA will direct any questions to the Reserve point of contact.

The Panel Summary should be submitted to NOAA by uploading the worksheet into the Google Drive folder for your reserve at the conclusion of the panel and no later than **April 10, 2020**. Please upload the Panel Summary as a separate pdf. The reserve will be contacted prior to NOAA making final funding recommendations to the Grants Management Division.

Marae Lindquist's fellowship proposal clearly rose to the top for the NC NERR fellowship panel with an average score of 2.9. Lindquist's proposal is ranked second by the merit reviewers with an average score of 93.7.

Lindquist proposed a novel and ambitious project that will identify how marsh bird populations may be affected by sea level rise. She clearly defined how her proposed research meets many of the NC NERR management needs and references state, federal and regional action plans to support the proposed research. The project spans multiple NC NERR sites, leveraging the comparative nature of a multi-component reserve, and will enhance integration of the applicant with the NC NERR as core staff and programs are located and implemented across the NC NERR sites selected for the project. The NC NERR fellowship panel recognized that the information generated by this project could be used for multiple applications by the NC NERR, including helping the reserve prioritize areas/habitats to conserve/restore and determining the vulnerability of reserve sites to sea level rise. Upon the start of the fellowship, NC NERR will work with the applicant to further develop a collaborative science plan that connects her with additional partners.

The applicant explicitly describes her engagement with the reserve and expresses interest in the career development opportunities of the fellowship, demonstrating interest in other key aspects of the fellowship program. Further, the panel appreciated that the applicant had already talked with NC NERR staff about getting to field sites.

Lindquist has a proven track record and strong support from mentors and proposed collaborators which will ensure a successful working relationship with the NC NERR fellowship mentor. The NC NERR panel agreed that Lindquist's proposal provided the greatest opportunity to meet reserve needs and integrate with the reserve, thereby providing meaningful fellowship experiences for both the applicant and the NC NERR.